CBCS SCHEME

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BPHYE102/202

# First/Second Semester B.E./B.Tech. Degree Examination, Dec.2023/Jan.2024

## Applied Physics for EEE Stream

Time: 3 hrs. Max. Marks: 100

***Note:*** **1.** ***Answer any FIVE full questions, choosing ONE full question from each module.***
**2.** ***VTU Formula Hand Book is permitted.***
**3.** ***M : Marks , L: Bloom's level , C: Course outcomes.***
**4.** ***Speed of light*** $c = 3 \times 10^8$ ***m/s,*** $K = 1.38 \times 10^{-23}$ ***J/K,*** $h = 6.625 \times 10^{-34}$ ***JS,*** $g = 9.8$ ***m/s***$^2$, $\epsilon_0 = 8.854 \times 10^{-12}$ ***F/m***

| | | Module – 1 | M | L | C |
|---|---|---|---|---|---|
| Q.1 | a. | State and explain Heisenberg's uncertainty principle and show that there is no existence of electrons in the nucleus of an atom. | 9 | L2 | CO1 |
| | b. | What is a wave function, probability density and normalization of wave function? | 7 | L2 | CO1 |
| | c. | Find the lowest energy of an electron confined to move in a one dimensional potential box of length 1A in electron volts. | 4 | L3 | CO1 |
| | | **OR** | | | |
| Q.2 | a. | Setup time Independent Schrodinger's wave equation for a particle in one dimension. | 7 | L2 | CO1 |
| | b. | Discuss the wave functions, probability densities and energy for a particle in a box by considering the ground state and first two excited states. | 9 | L2 | CO1 |
| | c. | Calculate the de-Broglie wavelength of an electron when it is accelerated to a potential of 5000 V. | 4 | L3 | CO1 |
| | | **Module – 2** | | | |
| Q.3 | a. | Mention any three assumptions of quantum free electron theory. Discuss the variation of Fermi factor with temperature and energy. | 9 | L2 | CO1 |
| | b. | Explain the construction and working of MAGLEV vehicle. | 6 | L2 | CO1 |
| | c. | An elemental solid dielectric material has polarizability of $7 \times 10^{-40}$ $Fm^2$. Assuming the internal field to be Lorentz field, calculate the dielectric constant for the material if the material has $3 \times 10^{28}$ atoms/$m^3$. | 5 | L3 | CO1 |
| | | **OR** | | | |
| Q.4 | a. | What is super conductivity? Describe Type-I and Type-II superconductors. | 7 | L2 | CO1 |
| | b. | What is dielectric polarization? Explain various types of polarization mechanism. | 8 | L2 | CO1 |
| | c. | Calculate the probability of an electron occupying an energy level 0.02 eV above the Fermi level at 200 K and 400 K in a material. | 5 | L3 | CO1 |
| | | **Module – 3** | | | |
| Q.5 | a. | Obtain an expression for energy density of radiation under thermal equilibrium conditions in terms of Einstein's coefficients. | 8 | L2 | CO2 |
| | b. | What is attenuation? Explain different types of attenuation in optical fibers. | 8 | L2 | CO2 |
| | c. | The average output power of laser source emitting a laser beam of wave length 6328 A is 5 mW. Find the number of photons emitted per second by the laser source. | 4 | L3 | CO2 |
| | | **OR** | | | |

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|---|---|---|---|---|---|
| Q.6 | a. | What is numerical aperture? Obtain an expression for numerical aperture interms of refractive indices of core and cladding of an optical fiber. | 9 | L2 | CO2 |
| | b. | Describe the working of a laser printer. | 6 | L2 | CO2 |
| | c. | The attenuation of light in an optical fiber is estimated at 2.2 dB/km. What fractional initial intensity remains after 2 km and after 6 km. | 5 | L3 | CO2 |
| | | **Module – 4** | | | |
| Q.7 | a. | State and prove Gauss Divergence theorem. | 7 | L2 | CO3 |
| | b. | Explain Faraday's laws of electromagnetic induction and amperes law. Express the same in point form. | 8 | L2 | CO3 |
| | c. | Determine the constant c such that the vector $\vec{A} = (x + ay)\hat{a}_x + (y + bz)\hat{a}_y + (x + cz)\hat{a}_z$ is solenoidal. | 5 | L3 | CO3 |
| | | **OR** | | | |
| Q.8 | a. | Derive wave equation in terms of electric field using Maxwell's equations for free space. | 8 | L2 | CO3 |
| | b. | Discuss continuity equation. Derive the expression for displacement current. | 8 | L2 | CO3 |
| | c. | Calculate the curl of $\vec{A}$ given by $\vec{A} = (1 + yz^2)\hat{a}_x + xy^2\hat{a}_y + x^2y\hat{a}_z$. | 4 | L3 | CO3 |
| | | **Module – 5** | | | |
| Q.9 | a. | Derive an expression for electrical conductivity in extrinsic and intrinsic semiconductors. | 8 | L2 | CO4 |
| | b. | Describe the construction and working of semiconductor laser with energy level diagram. | 8 | L2 | CO4 |
| | c. | The Hall coefficient of a specimen of a doped silicon is found to be $3.66 \times 10^{-4}$ $m^3/c$. The resistivity of the specimen is $9.93 \times 10^{-3}$ ohm-m. Find the mobility and charge carrier density assuming single carrier conduction. | 4 | L3 | CO4 |
| | | **OR** | | | |
| Q.10 | a. | Explain Fermi level in an intrinsic semiconductor and derive the relation between Fermi energy and energy gap for an intrinsic semiconductor. | 9 | L2 | CO4 |
| | b. | Explain construction and working of photo diode. | 7 | L2 | CO5 |
| | c. | The resistivity of intrinsic germanium at 27°C is 0.47 ohm-meter. If the electron and hole mobilities are 0.38 $m^2$/VS and 0.18 $m^2$/VS respectively. Calculate the intrinsic carrier density. | 4 | L3 | CO4 |



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